

# **Sources of conflicts in climate policy within the EU**

**An economic analysis**

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## **CICERO**

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## Abstract

This report is a part of a study of the potential for the EU to take on leadership in the climate negotiations. The aim of this part is to sort out factors that may explain the different economic interests in cutting CO<sub>2</sub>-emissions within the EU. It is based on the idea that interests occur as a result of different perception of the cost of emission cuts among stakeholders. Sector-based comparisons of France, Germany, Italy, the Netherlands, Spain and United Kingdom indicate that the conflicts resulting from an announcement of emission cuts are likely to be moderate in Germany, the Netherlands and United Kingdom, while the possibility for conflicts in France, Italy and Spain are significantly higher. The explanation can to a large extent be found by the possibilities for reducing emissions in the electricity sector.

The differences facing the different countries when it comes to emission cuts might explain why the EU has not succeeded in implementing common measures across the member countries. To prepare for a common policy, a co-ordination of the electricity market should be given priority. Meanwhile, the differentiation of targets agreed upon after Kyoto clearly contributes to mitigate conflicts. On the other hand, new conflicts may occur as a result. The present analysis points out that Italy has got very strict targets compared with the other countries, while the targets for the Netherlands and Spain are moderate.

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# 1 Introduction

According to the Kyoto protocol from December 1997, the EU should commit itself to reduce their emissions of greenhouse gases by 8 percent on average over the period 2008 to 2012, compared with 1990. Considering the potential of low-cost measures to reduce greenhouse gases available in the EU, the chance of fulfilling this target is considered to be relatively good. However, the required efforts needed to succeed vary greatly among member countries, even though the internal differentiation of emission cuts within EU reduces the obstacles considerably. Still, a lot of problems remain. These relate inter alia to the monitoring and reporting of emissions, particularly of greenhouse gases other than CO<sub>2</sub>, procedures for reporting cross-national activities such as activities implemented jointly and trading of quotas, and not least to the responsibility for the achievement of the targets.

These problems are of course not 'EU-specific'. They apply to the implementation of the Kyoto protocol in general, and represent larger challenges when considering all Annex B countries than the challenges faced internally by the EU. Existing institutions and political infrastructure of the EU facilitates a solution to these problems. EU has thereby got a 'flying start' when it comes to the management of diverging interests among countries arising from the commitments of the Kyoto protocol on a global scale. If the EU manage to deal with the problems satisfactorily and succeeds in implementing the policy internally, they have an opportunity to 'set an example' for the global implementation of the treaty, and thereby perform directional leadership.

The obstacles for a successful climate policy, globally as well as within the EU, are closely related to conflicts of interests among countries and among stakeholders within countries. The ability to solve these problems depends partly on the extent of these conflicts and partly on the competence of the institutions responsible for the implementation of the policy. A premise for the EU to perform directional leadership is that the conflicts of interests are portrayed and well understood and that adequate institutions, measures and instruments are present. This paper highlights potential conflicts that may occur as a result of the anticipated economic consequences of cuts in greenhouse gas emissions. It is recognised, though, that conflicting interests cannot be considered independent of the institutional framework, nor that conflicts may arise due to other than economic factors. In particular, the choice of instruments and measures constitutes a considerable potential for both increasing and mitigating the potential conflicts.

An example of how significant economic factors may be for the choice of climate policy was demonstrated by EU's proposal of internal differentiation of emission cuts prior to the Kyoto meeting. The proposal was based on the so-called Triptych approach, which emphasises expected economic growth, energy intensive industry's share of total industrial output and on the characteristics of the energy supply system, such as the content of nuclear power (Ringius, 1999)

In this paper, we study similar characteristics of EU countries to portray the different economic interests within and among countries. The analysis is based on the idea that emission cuts represent a potential cost to industries and individuals. Whether the proposed cuts are accepted or repelled depends on how large these costs are expected to be. We discuss two aspects of the expected costs. First, we assess the expected increase in the cost of

production or consumption resulting from a given carbon tax. Second, we discuss on an informal basis the possibilities for implementing new technologies and thereby saving energy within sectors, or to reduce emissions of other greenhouse gases. These possibilities may be considered as the availability of options to reduce greenhouse gas emissions not necessarily invoked by taxes. The analysis provides a basis for studying possible internal and external conflicts. The cost of restructuring the economy as a result of carbon cuts is analysed by a demand scheme showing the cost facing different sectors of the economy as a consequence of a carbon tax. The ability to restructure the economy is further analysed by a general discussion of available options in different sectors to reduce emissions of CO<sub>2</sub>, save energy, or to reduce the emissions of other greenhouse gases than CO<sub>2</sub>.

The paper examines six EU-countries, France, Germany, Italy, the Netherlands, Spain and United Kingdom. These countries cover nearly 85 percent of EU's total population and more than 85 percent of the CO<sub>2</sub>-emissions. They also reflect typical views on environmental policy issues represented in the EU. In the context of climate policy, Ringius (1999) divide the EU countries into three categories: The 'green and rich' countries, the 'not so green, but rich' countries, and the 'less rich' countries. Among the first ones, we find Germany and the Netherlands. France, Italy and United Kingdom belong to the second category, while Spain is in the third.

Section 2 presents the methodological basis for the study. The six country studies are presented in section 3. Section 4 compares the results for the different countries. Potential external and internal conflicts of interests are discussed, and possible ways to mitigate the conflicts are considered. Section 5 concludes the paper.

## 2 Methodology

### 2.1 Measures and instruments

To identify the costs of developing and implementing a climate policy, one needs to define the potential of relevant measures and instruments. Analyses of climate policies traditionally distinguish between direct and indirect instruments. Direct instruments comprise regulations, public investments, laws, standards, etc. while indirect instruments comprise economic instruments, such as charges of taxes.

Measures to be used as direct instruments in climate policy are usually analysed by means of a bottom-up approach with a relatively detailed specification of the technologies of alternative options.<sup>1</sup> Bottom-up studies are useful when surveying the potential of new alternative technologies and for studies of direct instruments. The economic evaluation of measures in such studies is usually done by traditional cost-benefit analysis, based on observed prices.

The best way to study the effect of economic instruments, which aim at reallocating resources by changes in relative prices, is by macroeconomic top-down models.<sup>2</sup> There are tendencies towards drawing a borderline between the approaches in saying that bottom-up analyses favour the use of direct measures, while top-down studies favour taxes and charges. This borderline is, however, not at all clear. Both kinds of instruments may be analysed within both analytical approaches. This is the view taken in this paper, where we develop a demand scheme for fossil fuels based on a top-down approach and discuss measures sector by sector from a general 'bottom-up' point of view.

In mixing the two approaches we may hope to draw the advantage of both, but we also run the risk of comprising the weaknesses of both. In particular, there is a chance of leaving out important options, or to count them twice. To try to keep track of this problem, a discussion of how technologies are represented in bottom-up and in top-down models may be useful.

Bottom-up studies aim at evaluating new technologies by identifying and describing them in terms of energy effectiveness and usage, often in great detail. The studies emphasise technological characteristics, and require substantial insight in energy engineering. The detailed description of the technologies allows for assessments of the costs of implementation, based on observable cost components, and for assessments of benefits, e.g. in terms of value of saved energy and/or a valuation of reduced emissions.

In top-down models the technology is represented by estimated production functions for an aggregate of enterprises and technologies. The production functions are chosen under the assumptions of general properties important for economic decision making, and parameterised by means of observations for a year or for a period of time. It is impossible to identify specific technologies in such a model. For instance, one cannot say whether or not the potential for an introduction of heat pumps in public buildings is utilised. If based on time series data, the aggregate production function will, however, include observed technological change during

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<sup>1</sup> See e.g. COHERENCE (1991), UNEP (1994), Kram and Hill (1996) and Grubb et al. (1993)

<sup>2</sup> See e.g. Nordhaus (1993), Manne and Richels (1991), Peck and Teisberg (1994), Oliveira-Martins et al. (1993), Dean (1993), Edmonds and Barns (1992).

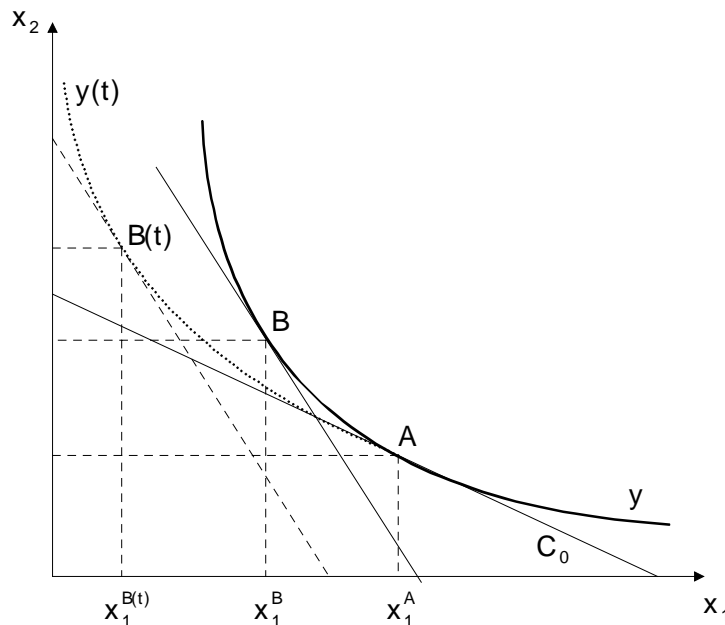


the observation period. The answer as to whether heat pumps are included is 'yes' if heat pumps represent a natural 'prolongation' of technologies introduced within the time perspective and range of relative prices of the study, and 'no' if not.

The advantage of top-down models is that they enable studies of changes in relative prices. In particular, they apply for studies of the consequences of a carbon tax. Such studies are important in assessments of the national cost of climate policies for two reasons. Firstly, although taxes are unlikely to be implemented on a common basis for the EU, it may constitute a vital part of single countries' climate policy. Secondly, taxes at least on CO<sub>2</sub> emissions, can be interpreted as the social cost of emission cuts. Even though the representation of alternative technologies in top-down models is vague, the analysis of taxes therefore provides important and necessary information about social costs.

A graphical illustration of how technologies are represented in the two approaches is given in figure 2.1. The  $x_1$ -axis measures the input of energy, causing emissions, to the production of a commodity aggregate,  $y$ . The  $x_2$ -axis measures the input of other commodities, which causes no emissions of greenhouse gases. The production technology described in a macroeconomic model is represented by an iso-curve  $y$ , along which combinations of  $x_1$  and  $x_2$  produce exactly the same quantity of output. At a given set of prices, the production cost represent a straight line for which combinations of  $x_1$  and  $x_2$  result in the same costs,  $C_0 = p_1 x_1 + p_2 x_2$ . The combination of  $x_1$  and  $x_2$  that minimises the cost of producing  $y$  is the point at which the  $y$ -curve and the  $C_0$ -line are tangent to each other, that is point  $A$ .

**Figure 2.1: Illustration of top-down and bottom-up studies of emission cuts.**



The slope of the cost curve depends on the prices of  $x_1$  and  $x_2$ . An increase in the price of  $x_1$  relative to the price of  $x_2$  makes the slope of the cost curve steeper. The cost minimising combination of  $x_1$  and  $x_2$  thereby shift to point  $B$ . The resulting reduction in emissions, indicated by the change in  $x_1$ , is critically dependent on the shape of the iso-curve  $y$ . Since the

parameterisation of top-down models is usually based on observations, one may argue that it is unlikely that new technologies are captured by the iso-curve  $y$ . Moreover, there may be adequate available measures not initiated by taxes. These are certainly not included. This applies, for example, to a large extent to measures directed against other emissions than CO<sub>2</sub> (Aaheim, 1998). One may therefore argue that the  $y$ -curve is too conservative and that it should be replaced by an alternative iso-curve that embeds new technologies,  $y(t)$ , and hence that point  $B$  should be placed further to the left, to  $B(t)$ .

To analyse the perspectives of both the bottom-up approach and the top-down approach, we divide the study of each country into two parts in this report. First, a partial analysis of the cost of reducing carbon emissions by sector is carried out by means of a demand scheme presented below. The demand scheme helps us find the demand driven effect on the production cost of a carbon tax. This 'cost push' will be interpreted as the anticipated cost of a given cut in emissions initiated by taxes. Next, we discuss alternative ways to cut emissions by reducing energy demand, apply alternative technologies or to cut other greenhouse gases. The availability of alternatives differs strongly from sector to sector, and even within sectors. The discussion of alternative ways to adapt to a carbon tax will be based on fairly general characteristics of each sector. These characteristics are pointed out in section 2.3.

It must be emphasised that this two-step approach is not methodologically consistent. A full top-down model would analyse how a tax affects equilibrium prices. Instead, we interpret the demand driven cost-push of a tax as an indicator of how costly a given reduction in emissions is expected to be. The choice of parameters in the demand scheme (or curvature of the iso-curve  $y$ ) assesses in principle the options discussed on a sector basis. However, a lot of informal, but useful, information is lost by aggregation of technologies. An ad hoc discussion of options sector by sector may provide a better foundation for portraying the problems of implementing climate policy than a full top-down analysis, with its limited representation of policy measures and options.

## 2.2 A scheme for the analysis of energy demand by sector

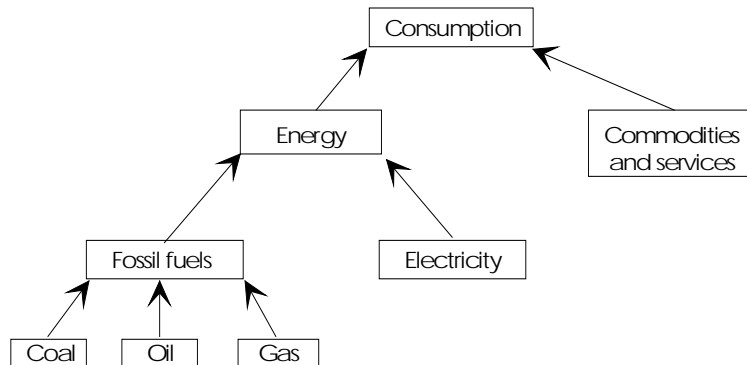
The aim of the demand scheme is to provide an indication of the costs of imposing a carbon tax. The general idea is that a carbon tax affects the prices of coal, oil and gas differently according to the carbon content of energy. Hence, the demand for fossil fuels will tend to increase for gas, which has the lowest content and thereby the lowest tax, at the expense of oil and coal. However use of fossil fuels may be substituted by electricity, and the substitution between fossil fuels and electricity also depends on how electricity is affected by the tax. This depends on the level of input of fossil fuels in the electricity sector. Energy is an aggregate of fossil fuels and electricity, and may be substituted by other commodities. Again, the substitution depends on the carbon content both in energy and in the other input. Hence, the carbon tax has a series of effects through the whole economy, before we can say what the cost eventually is to a sector or to the nation.

The structure of the demand scheme for fossil fuels is shown in figure 2.2. The economy is divided into four sectors: production of commodities, production of services (including transport), production of electricity and households. The demand for fossil fuels in each sector is found by 'nesting' the demand for sub-groups of commodity aggregates: The output from

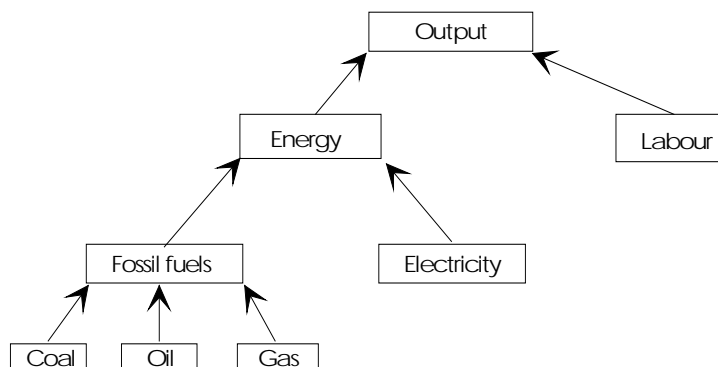
the service sector and the commodity sector is modelled as a function of input of labour and energy. Energy is 'produced' by fossil energy and electricity, and fossil energy is the product of input of coal, oil and gas. The demand for energy in households has a similar structure, with the exception that total consumption is 'produced' by energy and other commodities and services.

**Figure 2.2: Demand scheme for fossil fuels.**

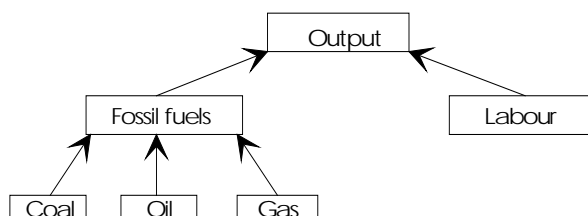
*HOUSEHOLDS*



*COMMODITY SECTOR AND SERVICE SECTOR*



*ELECTRICITY SECTOR*



The input of energy to the electricity sector consists only of fossil fuels in the model. In addition, supply of electricity may be provided by other energy sources, such as nuclear power or hydro-power. These sources are not explicitly included in the demand scheme, since they

are considered to be unaffected by a carbon tax. In countries where a large part of the electricity supply is based on other sources, such as France, the price of electricity is therefore relatively insensitive to a carbon tax. The immediate push in costs caused by a carbon tax is therefore relatively small. On the other hand, the emission intensity in the over-all economy is low because of the large amount of nuclear power. As a result, substitution towards less emission intensive demand is more expensive than in economies with coal-based electricity.

The characteristics of each sector are specified by the choice of parameters in the demand scheme. Technically, it is assumed that the generation of each commodity is described by a constant elasticity of substitution (CES) technology. This means that the percent reduction in relative input of two factors resulting from one percent increase in their relative prices is the same, regardless of on the composition of the two factors. The elasticity of substitution is chosen by assumption. We use the same elasticity for all countries to facilitate a comparison of the various possibilities on the supply side within the same sectors across countries. The characteristics of sectors within a country are captured by the parameters describing the distribution of input. These parameters are calibrated by national accounts data for 1994. The chosen set of elasticity of substitution at the different levels is shown in table 2.1.

**Table 2.1: Elasticity of substitution by sector. All countries.**

<b>Sector</b>	<b>Fossil fuels</b>	<b>Energy</b>	<b>Output</b>
<i>Electricity</i>	0.625	-	0.588
<i>Commodities</i>	0.714	0.909	0.800
<i>Services</i>	0.500	0.444	0.980
<i>Households<sup>1</sup></i>	0.909	0.909	0.645

1) Output is total consumption

The elasticity of substitution among fossil fuels is generally assumed to be low (little flexibility), except for households, which is assumed to have a potential for flexibility in heating. Also the service sector uses a relatively large share of their fossil fuels to space heating, but this sector also includes the transport sectors, which is more or less determined to oil. The flexibility in the service sector is therefore assumed to be low. The energy demand is assumed to be flexible except for the service sector, for which the transport sector again limits the opportunities. In the electricity sector it is assumed that the opportunities for substituting electricity by other inputs, here labour, are small. The opportunities for substituting energy by labour are greater in the commodities and service sectors. Finally, households are not expected to be able to substitute energy by other commodities easily.

The purpose of the demand schemes is to find how sensitive the demand for fossil fuels is to carbon taxes. These are found by imposing a carbon tax on the use of fossil fuels to obtain a 10 percent reduction in CO<sub>2</sub> emissions. The measures we use are supposed to indicate how costly an implementation of cuts in the emissions of CO<sub>2</sub> is anticipated to be to the different sectors. Note, however, that the effects found by the demand scheme are based on a 'myopic' view on the effects of a tax on costs, since market effects of the tax are disregarded. We use two indicators to analyse this cost:

- *The cost-push indicator* tells how much the unit production cost in a sector increases by a given reduction in national CO<sub>2</sub> emissions, achieved by a carbon tax. This cost depends on the composition of fossil fuels in the final input and on the ability to substitute towards input with lower emissions. The indicator thus gives the elasticity of costs with respect to national carbon cuts.
- *The anticipated unit cost of emission reductions* is the cost-push per unit of reduced CO<sub>2</sub> emissions. These vary across sectors in the analysis, while in an equilibrium model, they would all be the same. Hence, they indicate which sectors might have to abate more than indicated by the reduction in energy demand from a tax, and which sectors might have to reduce less. Alternatively, they indicate in what sectors a myopic view on taxes exaggerates the final costs, and in what sectors a myopic view underestimates them.

In studying attitudes towards instruments and measures in climate policy, the anticipated unit cost of emission reductions may explain differences in attitudes across sectors. A high anticipated unit costs implies incentives to find less costly ways to reduce emissions, e.g. by trying out non-conventional technologies. A low anticipated unit cost means that the sector will probably insist on free quotas instead of taxes, since they are able to reduce emissions more than average with ‘internal’ measures and still pay less than their cost-effective share indicates. This applies in particular if the cost-push indicator is relatively high.

## 2.3 Opportunities on the supply side

The change in energy prices eventually brought about by implementation of a carbon tax depends on the characteristics of the production technologies, here called the supply side. Different from macroeconomic models, this study bases the reactions on the supply side on an ad hoc discussion of technological options in each sector. The aim of this discussion is to explore how smoothly the supply side is able to adapt to emission taxes by application of new technologies and a shift in the demand for energy. Sectors with little flexibility in this respect may either try to avoid targets for their own sake, or suggest alternatives to a tax. The outcome of this exercise is to point out sectors where conflicts are most likely to occur. The studies of single countries will be based on a rather general discussion of options available in different sectors. Below follows some characteristics of importance in such a discussion.

### 2.3.1 The electricity sector

The technologies applied for generating electricity are extremely important in an analysis of options to reduce CO<sub>2</sub> emissions, due to the huge contribution to total emissions from this sector. Production of electricity in many of the countries studied is heavily based on coal or oil and to some extent on nuclear power and gas. Countries with a high share of coal plants have opportunities to switch towards energy types with lower emissions per produced kWh, such as gas. The possibility of doing so depends partly on the availability of gas. The northern countries are clearly better off than the southern countries in this respect. The Netherlands and United Kingdom possess their own resources, and Germany is a node in the European gas network.

The possibilities of extending the use of alternatives to fossil fuels may be important. However, the opportunities are limited. Renewable energy is generally considered to be either

fully exploited (hydro) or too expensive (wind, sun, waves etc), but major achievements may be obtained in the future in bringing the costs of utilising new renewable energy down (Flavin and Lenssen, 1994, Krause and Koomey, 1996). This may be important for the questions studied in this paper if the potential varies among countries. It is difficult to say whether this is the case, and possible consequences of an introduction of new renewable energy sources on a large scale will not be emphasised in this study.

Use of biomass also represents an opportunity, not only to reduce emissions, but also to stimulate sinks of CO<sub>2</sub>. Biomass fuel has, however, other local environmental disadvantages, and to base energy supply on biomass may therefore be problematic. Another possibility is of course nuclear power. In this study, we do not, however, consider nuclear power to be a possible rescue for the EU in its efforts to succeed in climate policy.

The technologies of power plants across Europe differ, and the effectiveness of the plants varies greatly. Variations in the emissions per produced kWh for different plants based on the same fuel indicate that the technology is old. Co-generation of electricity is considered to be one of the most promising means to reduce emissions of greenhouse gases from power plants. The costs of replacing old technology by co-generation plants may in many cases be covered by the benefits from an increase in the effectiveness of the energy use (Krause and Koomey, 1996), and thereby represents a no-regret option.

### **2.3.2 The commodity sector**

The commodity sector comprises manufacturing industry. This is a highly heterogeneous sector for which a close examination of possible opportunities for energy saving is impossible to carry out within the scope of this study. Since the main focus here is how the sector may respond to emission targets, and how they consider the implementation of a carbon tax, we will concentrate our discussion on a few general characteristics of the sector.

First, the contribution from energy intensive industries is important. These industries are usually dominated by big enterprises with considerable political power. A combination of political power and low-cost opportunities makes it unlikely that they are willing to accept costly measures to reduce emissions. As a consequence, they are sceptical to taxes, because energy represents a major cost component to them. A successful implementation of alternative instruments requires, however, that the authorities are conscious of the effectiveness of the alternatives. If alternative instruments are imposed to avoid conflicts with politically strong interests, they are not likely to have sufficient real effect on the emissions, and consequently, the reductions has to be carried out by others. This is not only ineffective from an economic point of view, but also a source of conflict within countries as well as among countries.

Second, the extent to which other greenhouse gases than CO<sub>2</sub> are emitted may be important for the available options among measures and instruments. The Kyoto protocol regulates emissions of methane, nitrous oxide, hydrofluorocarbons, sulphur hexafluoride and perfluorocarbons in addition to CO<sub>2</sub>. Methane and nitrous oxide are emitted from industry, agriculture and from waste deposits, while most of the emissions of the remaining three greenhouse gases are related to industrial processes. Large emissions of these compounds allow for a more flexible, and thereby a less controversial implementation of a climate policy.

### **2.3.3 The service sector**

The two main utilities of energy use in the service sector are indoor heating or cooling of commercial buildings and transport. Energy use per room volume in commercial and public buildings is two to three times as high as energy use in households. Hence, the potential for energy saving and for substitution among energy carriers is generally believed to be large. However, it turns out to be very hard to reduce the energy use in the service sector. The effectiveness of energy use in service buildings was significantly enhanced during the oil price hikes in the 1970s and early 1980s. Today, the rate of growth in energy use is mostly related to economic growth and business cycles. There are, however, a lot of new appliances that may be utilised to reduce the energy use in buildings. These include more effective heating systems, low-energy light bulbs and automatic control and regulation systems. Some of these require relatively substantial investments, especially in old buildings. Hence, the introduction of new technologies in the service sector may take time.

The transport sector relies mainly on oil. Although experiments with alternative engines are continuously carried out, the dependency on oil in transport is expected to continue for a long time. The possibility for substitution among energy carriers is therefore considered to be very small. However, there is some potential for substitution between transport modes, such as car transport and rail transport. This may indirectly lead to substitution between oil and electricity. Also the energy effectiveness of engines will probably be enhanced in the future, but hardly enough to avoid a substantial increase in the total use of energy for transport purposes.

For the sector at large, we consider the opportunities for reducing the emissions of CO<sub>2</sub> to be limited. However, these opportunities are probably better the less the transport activities contribute to the whole sector. With some exceptions, the sector is characterised by many relatively small units. This suggests that one emphasise incentives as policy instruments. The potential for implementing no-regret options and to enhance energy effectiveness is traditionally considered to be higher in small units than in large ones. Hence, the effect of information may be positive in this sector.

### **2.3.4 The household sector**

The household sector has many similarities with the service sector. However, the units are smaller, and the demand for energy is probably more flexible in the household sector than in the service sector. Hence, the possibilities for substitution and the potential of getting no-regret options carried out are probably better. As for the service sector, incentives are likely to be the most effective, but also information campaigns may be useful.

### 3 Country studies

This section presents country studies of France, Germany, Italy, the Netherlands, Spain and United Kingdom. The country studies focus on sector interests, and conclude by suggesting how these may affect national interests. The discussion is focused on the characteristics of energy demand and CO<sub>2</sub> emissions within each sector in the six countries. The demand shifts are calculated on a basis of a carbon tax resulting in an immediate 10 percent reduction in CO<sub>2</sub> emissions. Recall that only the effects of a tax on demand is considered, and the figures should not be confused with the final cost of a 10 percent reduction in CO<sub>2</sub> emissions.

As a point of reference for this discussion, table 3.1 shows the average energy- and emission intensities<sup>3</sup> for all the six countries together. Clearly, the electricity sector is vital for the discussion of possible measures for climate policy in the countries included in this study. For obvious reasons the energy intensity of the sector is very high, and the sector accounts for more than 20 percent of total energy consumption. The CO<sub>2</sub> emissions amount to about 30 percent of the emissions from this area.

**Table 3.1: Energy and emission intensities for all six countries.**

	<b>Total</b>	<b>Commo- dities</b>	<b>Services</b>	<b>Elec- tricity</b>	<b>House- holds</b>
<i>Energy intensity (PJ/Mrd. USD GDP)</i>	7.55	5.34	4.00	52.89	1.52
<i>Emission int. (Mill t CO<sub>2</sub>/Mrd. USD GDP)</i>	0.46	0.30	0.27	4.66	0.07
<i>Share of GDP (percent)</i>	100	32.9	64.2	2.9	78.1
<i>Share of total energy use (percent)</i>	100	23.3	34.0	20.4	15.8

The energy intensities as well as the emission intensities in the commodity sectors are slightly above the intensities in the service sectors. The emissions in the service sectors are, however, higher than in the commodity sectors if related to the energy intensity. This is mainly because the transport sector is included in the service sector.

It is difficult to compare the household sector with the other sectors of the economy. However, energy consumption in households has some similarities with energy consumption in the service sector, with transport and space heating as main purposes. However, the composition of energy carriers on the two purposes is widely different. Moreover, space heating is considerably more energy demanding in the service sector than in households. Some of this difference may be explained by technical factors, but there are many unexplained differences as well.

<sup>3</sup> Energy use and CO<sub>2</sub> emissions refer to economic activity, which is GDP for 'total', the sectors' gross product in commodities, services and electricity, and consumption level in households. Sources of nuclear energy (e.g. energy content in uranium) are not included in the calculation of energy intensities in the electricity sector.



### 3.1 France

France differs from the other countries by its electricity supply, for which approximately 75 percent is based on nuclear power. Both the energy intensity and the emission intensity of the electricity sector are very low compared with the average. The low emission intensity in the households is due to relatively high share of electricity in energy consumption, but we also note that the energy intensity in households is lower than the average.

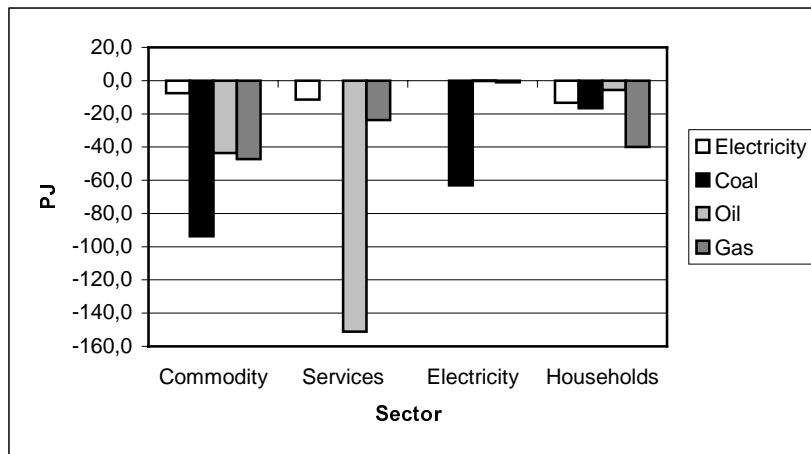
**Table 3.2 Main indicators for France.**

	<b>Total</b>	<b>Commo- dities</b>	<b>Services</b>	<b>Elec- tricity</b>	<b>House- holds<sup>1</sup></b>
<i>GDP (Mrd USD)</i>	1235	382	827	25	976
<i>Energy intensity (PJ/GDP)</i>	5.26	4.80	4.20	11.58	0.91
<i>Emission int. (Mill t CO<sub>2</sub>/GDP)</i>	0.31	0.27	0.27	1.09	0.03
<i>Cost push indicator</i>	1.33	1.59	1.14	3.88	4.07

The cost-push indicator for households is calculated as the cost-push for total energy use, and cannot be compared with the indicators for the other sectors.

The tax necessary to reduce CO<sub>2</sub> emissions by 10 percent in France is somewhat lower than the average. Because of the nuclear power, however, the cost-push indicator in the electricity sector is relatively small. Compared with the other countries, the total use of coal is low in France, except in the commodity sector, where coal contributes to a higher share of energy consumption than in most of the other countries. Most of the non-nuclear power is generated by coal. As shown in figure 3.1, a fair share of the emission reduction may therefore be obtained by reduction in the use of coal in the electricity sector. Also in the commodity sector, the demand for coal is reduced substantially. In total, most of the reductions of CO<sub>2</sub> emissions in France is divided between coal and oil. The reduction in the demand for oil is most significant in the service sector, which does not use coal. We also note the household sector reduces the use of gas as their main contribution to emission reductions. The reduction in the use of gas is significant in all sectors, except for the electricity sector. The reason is that gas is an important energy carrier in France, and that energy demand has to be reduced to reduce CO<sub>2</sub> emissions.

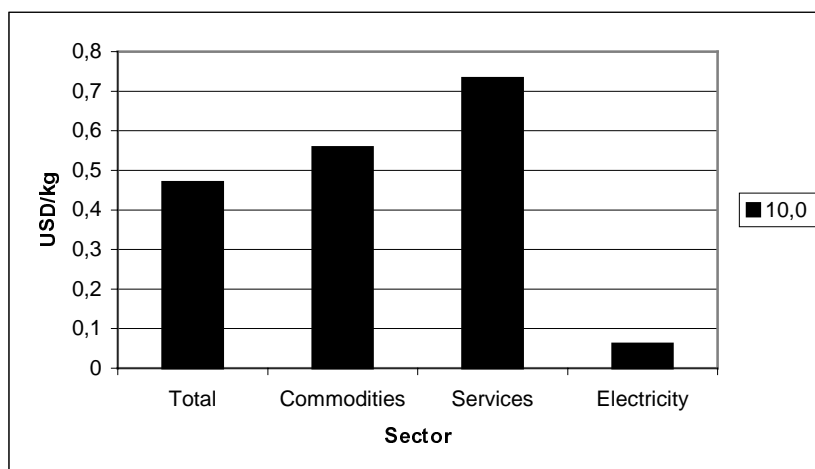
**Figure 3.1: Change in the demand for energy commodities by sector in France as a result of a carbon tax. PJ.**



The low tax to reduce emissions makes the cost-push indicator for France relatively low, that is, 1.33 percent per 10 percent reduction in the demand for CO<sub>2</sub> emissions. Due to the importance of coal, the costs of electricity generation is the most affected product, but the impact of the tax on the cost of electricity is much lower than in other countries. The reduction in oil consumption in the service sector is relatively expensive, and makes this sector more affected than the commodity sector. However, also the French commodity sector suffers significantly from the emission cuts because the possibility of reducing emissions indirectly by means of reducing electricity demand is limited. This limits the advantage of substitution for the commodity sector.

The anticipated unit cost of emission reductions is about 0.47 USD per kg CO<sub>2</sub>, see figure 3.2. The anticipated unit cost is lowest in the electricity sector, and highest in the service sector. As mentioned earlier, this could be interpreted as a motivation for finding alternative technologies to those traditionally included in the aggregate demand functions. Since these are expected to be low in the service sector, it is more likely that the sector interests tend to be in disfavour of climate measures. The commodity sector may probably underestimate the costs of emission reductions, and should therefore search for alternatives to traditional measures.

**Figure 3.2: Anticipated unit cost of carbon cuts by sector. USD/kg CO<sub>2</sub>.**



As mentioned, the opportunities on the supply side in the service sector are limited. For France, this applies in particular because transport contributes to a large share of the total activities of the service sector. The emissions from transport amounts to 35 percent of the sector's emissions, which is more than twice as much as for instance in Germany. Lower emissions from the transport sector requires first and foremost more energy effective cars, trains, planes and ships. Improvements are to be expected, but they will not change the opportunities in France relative to that of other countries.

The technological options beyond those implemented by taxes depend inter alia on the opportunities in various branches, particularly in the commodity sector. A closer study of sub-sectors in the French industry is required to make such an assessment. One possibility is, however, to reduce other gases than CO<sub>2</sub>. The emissions of other gases are relatively high, and constitute approximately 25 percent of total emissions of greenhouse gases in France. France contributes to 11 percent of EU's total emissions of N<sub>2</sub>O, of which more than half comes from the industry. The emissions of HFK and PFK are also large by European standards. This may open some opportunities in these industries.

To draw advantage of alternative technologies and reduction in emissions of other gases, the industries may try to obtain free quotas instead of paying taxes for CO<sub>2</sub> emissions. To achieve this requires a relatively close contact between the authorities and businesses. This is of course more urgent the higher the energy intensities of the enterprises are, and easier the larger they are. The importance of the heavy industry may give an indication of the possibility of obtaining alternative measures to taxes since the heavy industry usually fulfil this criteria. In France, heavy industry contributes 60 percent of the CO<sub>2</sub>-emissions from the total industry sector. This is low compared with other countries. Although there may be many opportunities to reduce emissions at a lower cost than indicated by the demand scheme, France's industry is likely to have smaller opportunities than other countries.

## 3.2 Germany

Germany's energy and emission patterns are, in contrast to France's, heavily influenced by the use of coal. Coal accounts for more than 80 percent of the energy input in the electricity sector, and the energy and emission intensities are twice as high as the average intensities for the six countries together. Also the households are relatively energy intensive, which is why the total emissions from the household sector are high. However, the intensities in the two production sectors are slightly below the average.

**Table 3.3: Main indicators for Germany.**

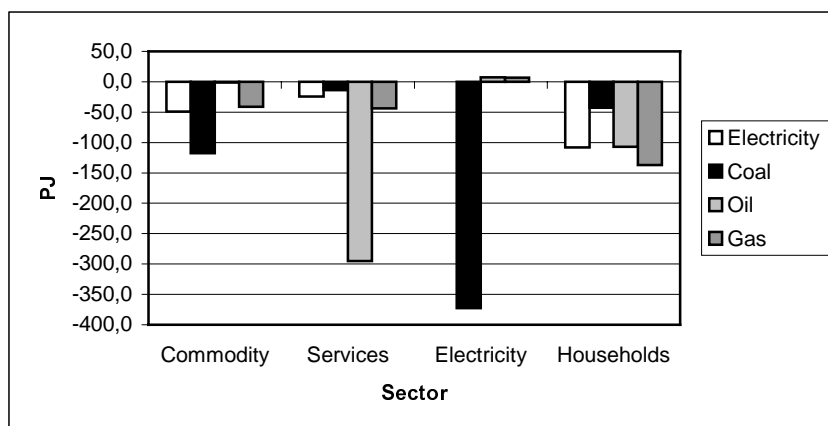
	<b>Total</b>	<b>Commo- dities</b>	<b>Services</b>	<b>Elec- tricity</b>	<b>House- holds<sup>1</sup></b>
<i>GDP (Mrd USD)</i>	1753	666	1052	36	1262
<i>Energy intensity (PJ/GDP)</i>	7.86	4.88	3.89	112.26	1.99
<i>Emission int. (Mill t CO<sub>2</sub>/GDP)</i>	0.55	0.28	0.27	10.44	0.10
<i>Cost push indicator</i>	8.37	12.92	5.02	22.21	22.03

1) The cost-push indicator for households is calculated as the cost-push for total energy use, and cannot be compared with the indicators for the other sectors.

Due to the dependency of coal, the tax level for Germany is relatively high. Although this leads to a considerable change in the energy demand, the total cost-push of a tax is the highest among the six economies. As a result of the tax, the demand for coal in the electricity sector is reduced to such an extent that the demand for oil and gas increases (see figure 3.3). It must be added that it is doubtful whether the demand for oil in the electricity sector will actually increase, since there are small chances that new power plants will be based on oil in the future.

In the commodity sector, the demand for oil is nearly unaffected as a result of the reduction in coal demand, but the total contribution from the German industry to the emission cuts is somewhat lower than usual for the countries studied here. On the other hand, households contribute more than usual for the other countries. The reduction in the demand for electricity, oil and gas in the household sector is approximately the same in terms of PJ, while the reduction in the demand for coal contributes somewhat less.

**Figure 3.3: Changes in the demand for energy commodities by sector in Germany as a result of a carbon tax. PJ.**



The anticipated cost increase in the electricity sector is 22 percent, which, together with the UK, is the highest among all the countries. The high cost-push for electricity leads to a high cost-push also for energy in the commodity, service and household sectors. This is because the prices of direct fossil input relative to electricity is affected only to limited extent, and the cost-push of energy thereby becomes higher than the cost-push for electricity. Thus, if the electricity sector manage to reduce emissions at lower costs than indicated by the macro figures, the potential for reducing emissions all through the German economy is large.

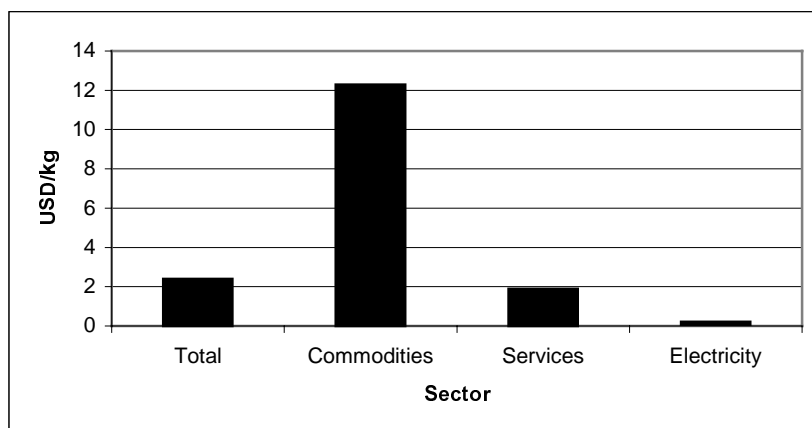
The vital question is therefore how the electricity sector adapts to a tax. An important factor in this context is the availability of alternative energy sources in Germany. Germany's own energy resources are practically speaking limited to coal, which is expensive. Hence, the electricity sector may also have economic reasons beyond those pointed out here, to reduce the demand for coal. In addition, Germany's central position for the transfer of gas from the North Sea and Russia, both geographically and economically, represents good opportunities for utilising alternatives to coal. Germany plans for a more extensive use of gas, but a main obstacle for a rapid expansion is the country's own coal industry, which will suffer from such a development. How the commodity sector reacts to a tax depends on the possibilities of finding alternative, less emission intensive technologies. A considerable potential is clearly represented by a rationalisation of the industry in the eastern region of the country.

Also for the service sector, the cost-push is in the higher range of the six countries studied. As for all the countries, the emissions are reduced mainly by a reduction in the consumption of oil. In Germany, the CO<sub>2</sub> emissions from transport contribute approximately 16 percent of the total emissions from the service sector. This is low compared with other countries. The possibilities of find less costly measures to reduce the emissions by energy saving, more efficient energy use in buildings etc. are likely to be good, since a large share of the energy consumption in the service sector is used for stationary purposes.

The commodity sector faces the highest anticipated unit costs among the sectors in Germany. This is due to a moderate energy intensity and relatively high costs-push, see figure 3.4. Hence, the motivation for implementing measures in the commodity sector is high. The

commodity sector also has an opportunity to reduce other gases than CO<sub>2</sub>, but these are less obvious for Germany than for other countries, since CO<sub>2</sub> emissions contribute to a relatively large share of total greenhouse gas emissions. The anticipated unit cost in the service sector is low, which may make it difficult to motivate a search for alternative measures to meet emission targets. Also the electricity sector faces a very low anticipated unit cost. This may turn out as an obstacle for a reduction if the emissions from the German electricity sector.

**Figure 3.4: Anticipated unit costs by sector for Germany.**



To sum up, an immediate evaluation of costs facing Germany by CO<sub>2</sub> emission cuts are large, due to their huge emissions. However, the options for low cost reductions are many, first and foremost by reducing the dependency of coal in the electricity sector. It is, however, important for the German authorities to motivate the electricity sector to reduce its emissions. On the other hand, the dependency of coal is also expensive for Germany, which uses a lot of high-cost coal from domestic deposits. Also the commodity sector embeds many opportunities, inter alia in the manufacturing industries in the former DDR. At the same time, these sectors seem to have the highest motivation for implementing new efficient technologies. Consequently, the potential conflicts resulting from climate policy targets are probably low.

### 3.3 Italy

The energy and emission intensities in Italy are low compared with the other countries in this study. This applies in particular for the service sector and in the electricity sector. Approximately 1/3 of the generation of electricity is based on hydro power. Gas contributes about thirty percent of the energy use in the commodity sector, which is almost as much as in the Netherlands. Oil contributes about 90 percent of the use of energy in the service sector.

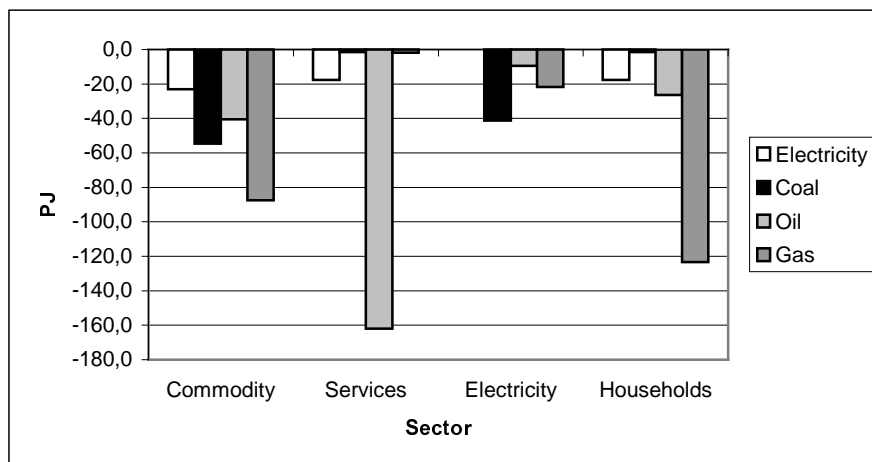
**Table 3.4 Main indicators for Italy.**

	Total	Commo- dities	Services	Elec- tricity	House- holds <sup>1</sup>
<i>GDP (Mrd USD)</i>	1127	3955	3812	173	4642
<i>Energy intensity (PJ/GDP)</i>	5.86	5.18	2.85	17.84	1.32
<i>Emission int. (Mill t CO<sub>2</sub>/GDP)</i>	0.36	0.28	0.19	2.06	0.07
<i>Cost-push indicator</i>	3.28	4.11	2.32	11.87	12.48

1) The cost-push indicator for households is calculated as the cost-push for total energy use, and cannot be compared with the indicators for the other sectors

The total cost-push of a carbon tax is higher than in Germany, Netherlands and Spain, but lower than in Germany and in the UK. However, due to Italy's high content of gas in the fossil fuel aggregate and low emission intensities, the cost-push of fossil fuels is relatively high. In the commodity sector and service sector, it is the highest among the countries studied here. In the electricity sector, the possibilities of substitution towards less emission intensive production are limited because electricity is largely based on oil and gas.

Figure 3.5 shows the change in the demand for energy commodities across sectors as a result of a carbon tax. The limited contribution from the electricity sector is noted. The main reductions have to be taken in the service sector, where oil contributes to most of the reductions, and from the commodity sector, where gas takes the main part of the reductions. This is true also for the household sector. The total reduction in the demand for energy carriers in Italy is therefore related to oil and gas. This partly explains why the cost of emission cuts turns out to be high. In addition, reductions that follows from the drop in the demand for electricity is expensive because of the limited flexibility of the sector.

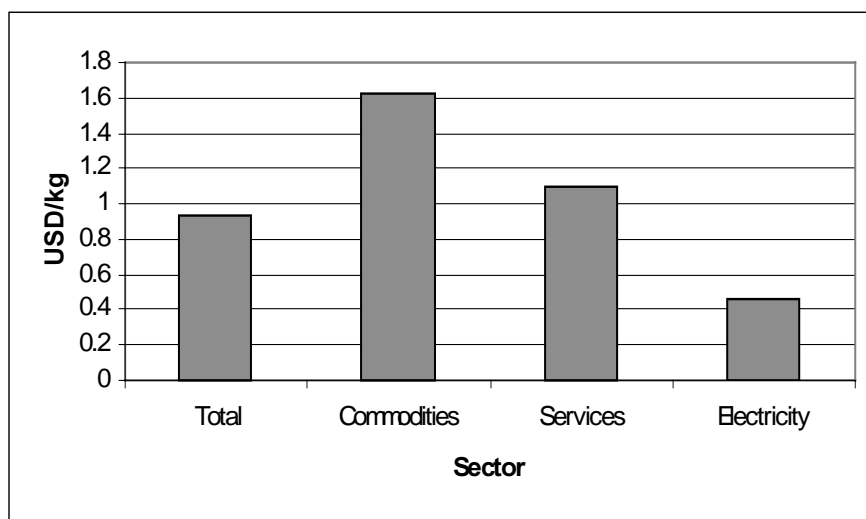
**Figure 3.5: Change in demand for energy commodities by sector in Italy as a result of a carbon tax. PJ.**

Because of the importance of the electricity sector, the options beyond those described by the demand scheme should be analysed. Figure 3.6 indicates that the sector has high incentives to

search for alternative technologies. Two third of the fuel consumption in the electricity sector consist of oil. Oil is expensive, and a substitution to gas in Italy's power generating industry may be both cost efficient and reduce the emissions of CO<sub>2</sub>. However, the potential for cutting emissions by substituting toward gas is much lower than in coal fired plants. The possibility of enhanced use of gas also depends on Italy's availability of gas. Gas reserves are limited within their own borders. Being close to North Africa the potential of buying new gas at low prices is, however, good, but perhaps politically difficult. An extension of the gas trade between Africa and Europe may also be advantageous to Italy by strengthening its role as a transmission country.

Taking into consideration the low contribution to total costs from electricity, the anticipated unit costs in the commodity and service sector are high compared with other countries. This may give Italian enterprises incentives to find new ways of reducing emissions, for instance by new and unconventional technologies, compared with similar sectors in other countries. The contribution to CO<sub>2</sub> emissions from the heavy industry is relatively high. In many cases, there are more available options for reducing the emission intensity in heavy industry than in other activities. This may contribute to make it easier to implement alternative measures to taxes, if the heavy industry is well organised and have close relations with the authorities. Within the service sector, the opportunities seem to be more limited, especially because transport contributes to a high share of the CO<sub>2</sub> emissions from this sector. The emissions of methane are among the largest of the six countries. A relatively small share of these emissions is related to fuels, and may represent additional opportunities for reduction of the emissions of greenhouse gases from waste and agriculture. The emissions of nitrous oxide is on the average, while emissions of the other greenhouse gases, HFK, PFK and SF<sub>6</sub> are negligible.

**Figure 3.6: Anticipated unit costs by sector for Italy.**



According to the demand scheme, the costs of adapting to cuts in emissions of CO<sub>2</sub> are high in Italy. This is mainly because the electricity sector is expensive and inflexible with respect to emissions. Other factors that may support scepticism towards a radical policy to reduce greenhouse gas emissions, is the fact that Italy already uses a lot of gas, and has a relatively low energy intensity compared with other countries. The households already use a lot of gas, and emission cuts will to a large extent require reductions in the total energy demand. The



possibilities of utilising alternative technologies seem to be limited, and, except for the case of methane, the same applies for measures to reduce emissions of other gases than CO<sub>2</sub>.

### 3.4 The Netherlands

Energy use in the Netherlands is characterised by a huge share of gas, which constitutes 45 percent of the total energy use. Gas is the major energy commodity in all sectors except for services, where 65 percent is oil-based. However, even the service sector exhibits a low share of oil compared with the other countries.

The importance of gas in the Netherlands' energy consumption is of course due to their gas reserves. The price of gas has been kept at a low level, and this may explain why the energy intensity is nearly three times as high in the Netherlands compared to the other countries in this study. Except for the service sector, the energy intensity is well above the average for all the countries. This is true especially in the commodity sector and the electricity sector. Also the emission intensity is high, but moderate compared with the energy intensity, because of the high content of gas in total energy consumption.

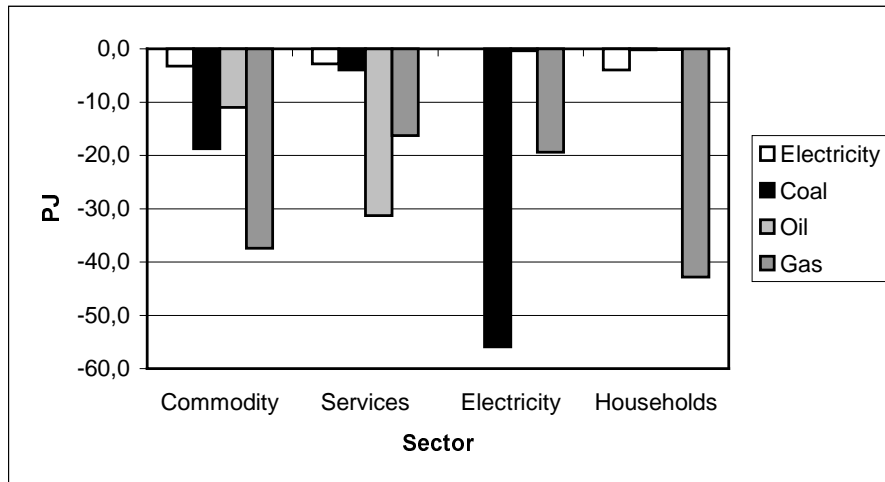
**Table 3.5: Main indicators for the Netherlands.**

	<b>Total</b>	<b>Commo- dities</b>	<b>Services</b>	<b>Elec- tricity</b>	<b>House- holds<sup>1</sup></b>
<i>GDP (Mrd USD)</i>	305	32	207	6	225
<i>Energy intensity (PJ/GDP)</i>	19.1	8.49	4.77	107.70	1.91
<i>Emission int. (Mill t CO<sub>2</sub>/GDP)</i>	0.58	0.47	0.31	8.03	0.09
<i>Cost-push indicator</i>	1.51	1.99	1.18	5.22	5.32

<sup>1</sup> The cost-push indicator for households is calculated as the cost-push for total energy use, and cannot be compared with the indicators for the other sectors

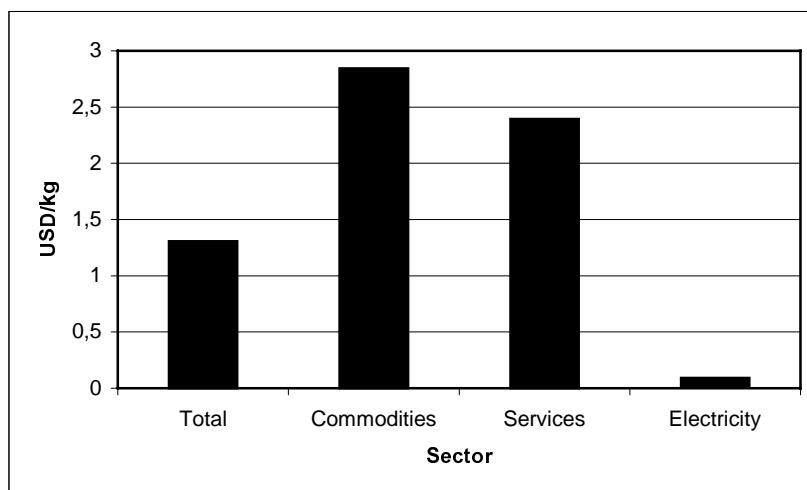
High energy intensities and a relatively flexible production structure, especially in the electricity sector, implies both that the tax needed to achieve a given reduction in emissions, and that the total cost-push resulting from a change of demand is small. In terms of costs, the Netherlands is the least affected among the countries studied here, since the large use of energy in general opens for a substantial substitution at relatively small changes in relative prices. According to figure 3.7, the main contribution to emission reductions from the electricity sector is a reduction in the demand for coal. This flexibility, together with a relatively low tax, leads to a lower increase of the electricity price than in most of the other countries. The reduction in demand for electricity is therefore relatively small, which means that electricity increases its importance in the energy system

**Figure 3.7: Change in the demand for energy commodities by sector in the Netherlands as a result of a carbon tax. PJ.**



The main difference between the Netherlands and the other countries is the extensive use of gas. According to figure 3.7, the reductions in the use of gas are substantial, and reflect the fact that gas has been priced very low. The household sector responds to a tax mainly by reducing the demand for gas. In the commodity sector, gas contributes to nearly twice as much of the emission reductions as coal. Also the service sector differs from other countries in the sense that gas constitutes an important share, although most of the reductions are related to oil. Due to the impact of gas, however, the emphasis on oil is less dramatic in the Netherlands, and reflects the fact that emission cuts in the Netherlands are relatively cheap.

**Figure 3.8: Anticipated unit costs by sector for the Netherlands. USD/Kg.**



According to figure 3.8 the distribution of anticipated unit costs across sectors exhibits approximately the same pattern in the Netherlands as in other countries. However, the relative unit cost of the electricity sector is low compared with other sectors, and is due to the high content of carbon in electricity production. Due to the seemingly large opportunities for

energy conservation across the sectors in the Netherlands, the level of the unit costs are lower than in other countries where the electricity sector is also dependent on coal.

The heavy industry contributes to a large share of the emissions from the commodity sector. The industry also generates relatively large emissions of HFK, PFK and SF<sub>6</sub>. For instance, the Netherlands' emissions of SF<sub>6</sub> contribute to half of the total emissions of SF<sub>6</sub> from the six countries, and 1/4 of EU's total emissions. This adds to the possibilities of low-cost emission reductions in the Netherlands. On the other hand, the anthropogenic emissions of methane are small, which means that direct measures in agriculture or in management of waste may not contribute substantially.

The Netherlands has played an active role in environmental policy processes, including the making of climate policy, within the EU. One reason for this is that environmental matters means much to the Dutch people, but also that the environmental problems are severe. The analysis above provides an additional explanation, namely that the costs of implementing climate measures are low. This is not evident, since the energy demand is heavily based on gas, the less pollution intensive of all fossil fuels. However, the intensive use of energy leaves a considerable room for substitution, and the total effect of an emission target is likely to be very moderate in the Netherlands. There are also indications that emissions may be reduced at low costs by alternative means, for instance by reducing the emissions of other gases than CO<sub>2</sub> in the commodity sector. Hence, the potential for a successful implementation of environmental policy is large.

### 3.5 Spain

Spain belongs to the 'less rich' EU countries, and it is expected that they will have a higher economic growth rate in the years to come than most other EU countries. This affects the costs of reducing emissions relative to a given base year, for instance 1990, considerably. When comparing the costs of cuts in the emissions of greenhouse gases with other EU countries, the expected economic growth in Spain therefore has to be considered as well. In this section, however, we focus mainly on internal differences and ask whether there are additional reasons for paying attention to the Spanish economy than the effects of unequal economic growth.

**Table 3.6: Main indicators for Spain.**

	<b>Total</b>	<b>Commo- dities</b>	<b>Services</b>	<b>Elec- tricity</b>	<b>House- holds<sup>1</sup></b>
<i>GDP (Mrd USD)</i>	511	174	317	20	409
<i>Energy intensity (PJ/GDP)</i>	6.95	5.57	4.73	36.11	0.85
<i>Emission int. (Mill t CO<sub>2</sub>/GDP)</i>	0.47	0.31	0.32	3.42	0.04
<i>Cost-push indicator</i>	2.72	3.52	1.59	13.51	12.99

1) The cost-push indicator for households is calculated as the cost-push for total energy use, and cannot be compared with the indicators for the other sectors

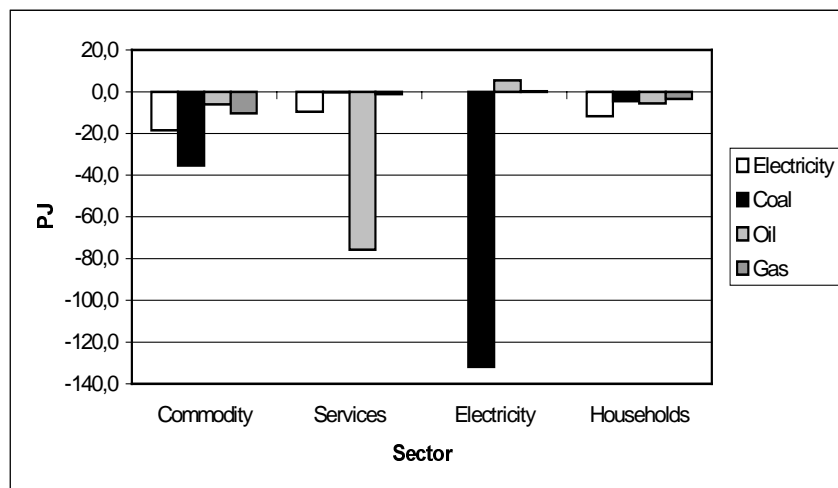
Oil contributes to 2/3 of the demand for fossil fuels in Spain. The fossil based electricity production, which constitutes the major part of the electricity sector, is mainly based on coal-fired plants. These plants demand more than 80 percent of the consumption of coal in Spain. Gas fired plants are unusual. In the households, coal contributes to about 3 percent of fossil fuel demand, and gas to about 12 percent.

As shown in table 3.6, energy and emission intensities are about the same as the average for the six countries. The energy and emissions intensities of commodity and service sectors are slightly above the average, while the intensities in the electricity sector and households are below average. For the electricity sector, this can partly be explained by the high intensities in some of the other countries, notably Germany, the Netherlands and the UK. But it may also be due to a relatively high price of electricity in Spain or to a high technical standard. In any case, the electricity sector in Spain is considered effective as a result. Moreover, Spain is rapidly increasing its dependence on nuclear power, which has nearly doubled over the last decade, and contributes at present to more the 1/3 of the electricity supply. The explanation for the low energy intensity in households is primarily the level of consumption in Spain.

The content of coal in the electricity sector is high, which leads to a considerable change in the demand for fossil fuels. The reduction in the demand for coal in this sector contributes to nearly half of the total reduction in energy demand in Spain. This leads to a considerable cost-push for electricity, although lower than in Germany and the UK. This has important consequences for the commodity sector, where the use of electricity is high. Since the cost of electricity increases substantially, the costs of the commodity sector also becomes large.

In Spain too, the service sector has to reduce its emissions mainly by reducing the demand for oil, but the service sector contributes to a smaller share of total reductions than in other countries. It might be noted, however, that if we disregard the effects of the price of electricity, the cost-push in service sector is the second highest among the six countries (after Italy). This implies that the flexibility of the direct use of fossil fuels is lower in the service sector in Spain than in other countries. Hence, the transport sector may be more vulnerable to emission cuts.

**Figure 3.9: Change in the demand for energy commodities by sector in Spain as a result of a carbon tax. PJ.**

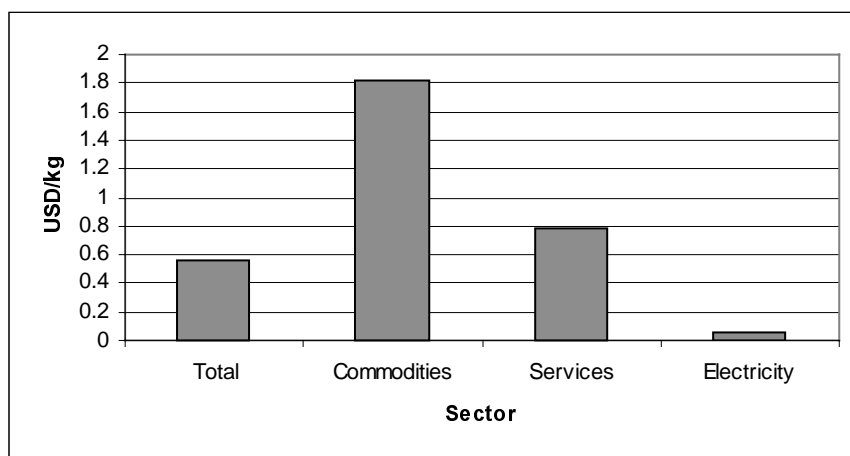


A tax leads to a reduction in the demand for coal of between 25 and 35 percent in the Spanish sectors. Figure 3.9 shows that the major contribution comes from the demand for coal by 130 PJ in the electricity sector, while the demand for oil and gas increases slightly in this sector. The contribution from the service sector is based on a reduction in the demand for oil, which leads to a relatively high increase in the cost of the energy aggregate of the sector. The commodity sector replaces electricity and coal by oil and gas, but the demand decreases for all energy commodities. In fact, 80 percent of the total reductions in Spain can be explained by reductions in the demand for coal in the commodity and the electricity sectors, and oil in the service sector. The low energy intensity explains why the contribution from the household sector to the emissions is moderate.

The motivation for finding alternative measures to taxes is highest in the commodity sector, partly due to their dependency of electricity. There may be additional opportunities to improve the technology in the industry sector, where heavy industry contributes to a large share. On the other hand, there are no emissions of HFK, PFK and SF<sub>6</sub>, so the flexibility with respect to reducing emission of other gases are small in the commodity sector.

As pointed out, parts of the service sector may face high anticipated unit costs. This may be critical, because the contribution to CO<sub>2</sub> emissions from transport is high, nearly 30 percent. The emission of N<sub>2</sub>O and CH<sub>4</sub> are, however, high compared with the CO<sub>2</sub> emissions. Agriculture contributes to 2/3 of the emissions of nitrous oxide, which is high compared with other countries. One reason is that the emissions of nitrous oxide from the industry are low, but there may be available measures in agriculture aiming at reducing these emissions at low costs.

**Figure 3.10: Anticipated unit cost of a carbon tax. USD/kg CO<sub>2</sub>.**



The importance of coal in the electricity sector in Spain clearly provides opportunities to reduce CO<sub>2</sub> emissions by substitution to less emission intensive production, but also leads to a significant increase in the cost of electricity. Hence, the possibilities, in particular for the commodity sector, to substitute from emission intensive to less emission intensive use of energy are limited. However, the service sector's ability to draw an advantage from this possibility is limited, due to the impact of transport. In total, Spain is therefore probably relatively vulnerable to climate policy. In addition, the expected economic growth rate

represents an obstacle for radical measures against greenhouse gas emissions. To include Spain in EU's efforts to perform leadership in climate negotiations therefore represents a major challenge to the union.

### 3.6 The United Kingdom

UK's energy reserves cover coal, oil and gas. The use of energy is distributed relatively equally between the three energy commodities for the country as a whole. The commodity sector emphasises the various energy types relatively equally, while each of the other sectors is dominated by one of the energy carriers. Oil dominates in the service sector for obvious reasons. 75 percent of the fossil fuel input in the electricity sector is coal, while gas contribute to nearly 2/3 of the energy use in households. According to the figures in table 3.7, energy and emission intensities in all the sectors are above the average for the six countries studied here. The emission intensity for the UK are among the highest in Europe. Due to the dependency of coal, the CO<sub>2</sub> emissions in the electricity sector are high, also with respect to the high energy intensity.

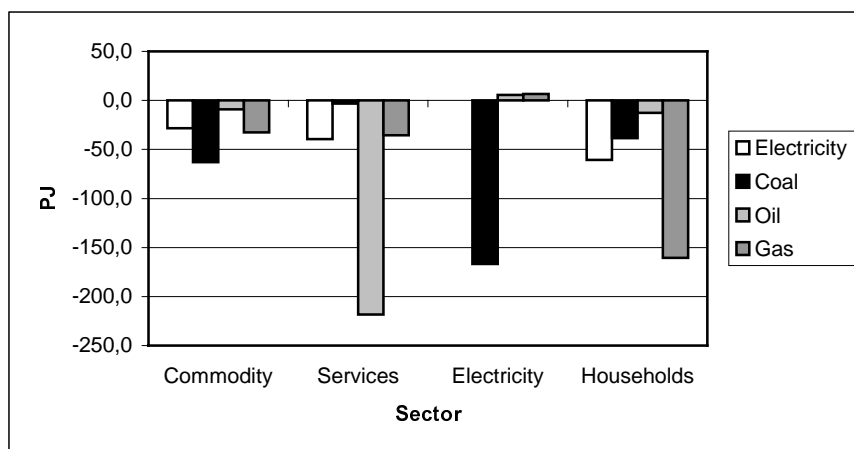
**Table 3.7: Main indicators for United Kingdom.**

	<b>Total</b>	<b>Commo- dities</b>	<b>Services</b>	<b>Elec- tricity</b>	<b>House- holds<sup>1</sup></b>
<i>GDP (Mrd USD)</i>	1009	303	676	30	868
<i>Energy intensity (PJ/GDP)</i>	8.53	6.12	4.58	64.72	1.96
<i>Emission int. (Mill t CO<sub>2</sub>/GDP)</i>	0.57	0.36	0.30	5.85	0.10
<i>Cost-push indicator</i>	7.79	10.93	5.79	22.83	22.74

1) Cost-push indicator for the households applies for total energy

The dependency of coal in the UK implies that the level of the tax is higher than average for the countries focused on in this study. Due to dependency of coal, the cost-push of the tax is substantial for economy as a whole and in particular for the electricity and household sectors. However, an expected restructuring of the electricity market in the UK, compared to the situation in 1994, is likely to bring about a substantial reduction in the emissions from the electricity sector. In particular, the commodity sector may draw an advantage of this, since the sector uses approximately equal amounts in each energy carrier. This allows for a relatively high flexibility of their energy use. This flexibility, combined with high emission intensities, makes the opportunities to reduce the total cost-push for the commodity sector bright. The other sectors have to base their adjustments on the energy carrier they use the most, and are left off with a higher cost-push.

**Figure 3.11: Change in the demand for energy commodities by sector in United Kingdom as a result of a carbon tax. PJ.**

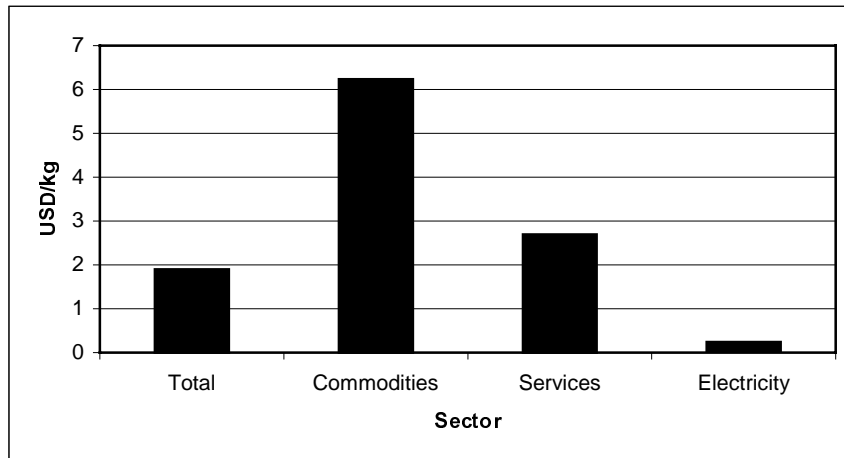


The contribution to the emission cuts from energy carriers and sectors are shown in figure 3.11. As for many other countries, the major contributions come from oil in the service sector and coal in the electricity sector. In addition, the reduction in the demand for gas in the household sector is significant.

The commodity sector anticipates the highest unit cost of emission reductions in the UK, as seen in figure 3.12. The unit cost for the commodity sector is high, also compared with most other countries, but only half as high as in Germany. The high levels of the anticipated unit costs are explained by the high total cost push for these countries in general. However, the commodity sector in the UK seems to be in a more advantageous situation than the German, due to a lower dependency of electricity and coal in total. Still, the incentives to search for new technologies are present, but the opportunity may be fewer than in Germany.

Although the incentives for the electricity sector to replace coal is low from a statistical point of view, the deregulation of the electricity market has already lead to an improvement of the effectiveness of the sector. The UK is about to reduce their dependency of coal in general. One option is to increase the use of gas in the electricity sector. The UK has access to gas resources both from own territories, and they are close to the gas reserves in other countries.

The emissions from agriculture are relatively low. This imposes some restrictions on the opportunities to find low-cost alternatives by reducing the emissions of CH<sub>4</sub> and N<sub>2</sub>O. The emissions of nitrous oxide from industry is, however, very high, and contribute to nearly 90 percent of total N<sub>2</sub>O emissions in the UK. Combined with outspoken incentives to replace old technologies, the opportunities to reduce emissions of other gases than CO<sub>2</sub> may be bright, especially since these emissions are not related to electricity prices. Thereby a moderate final cost of emission cuts may be achieved, and the scepticism towards emission targets within the commodity sector may therefore not be very widespread.

**Figure 3.12: Anticipated unit cost of a carbon tax. USD/kg CO<sub>2</sub>.**

Alternative opportunities in the service sector are limited. Transport contributes to 20 percent of the total CO<sub>2</sub> emissions, which is on the average for the six countries. However, the adaptation to taxes by substitution of energy carriers are somewhat better in the UK than in most of the other countries, since the sector uses more coal and gas than usual.

The dependency of coal in the UK economy might indicate that emission cuts would have substantial economic consequences, and that the country therefore should be negative to emission cuts. Apart from Germany, the anticipated cost of a 'would-be' carbon tax is high compared with the other EU countries studied here. However, the UK has much in common with Germany. The commodity sector is probably capable of adapting to cuts in carbon emissions without large costs. There are indications that this may be easier in the UK than in Germany. This may place them in an advantageous position compared with industries in other countries. A major obstacle for carrying through emission targets is thereby avoided. The other sectors also anticipate high costs, but for the electricity sector in particular, alternative modes of production with lower emissions are clearly available. Hence, despite the UK's presumed low concern for environmental problems, they may be positive to a collective action among member states for economic reasons.



## **4 Possible conflicts and the potential for leadership**

The country studies portray differences in expected costs among countries and among sectors within countries. These differences point at possible conflicts of interests that may have an impact on the EU's ability to take on a leadership role in the further negotiations in the international climate regime. Although based on economic factors, conflicts may be expressed as diverging views on seemingly other topics, such as the choice of appropriate measures. In this section, we will try to point out the relationship between areas of conflicts and the differences in costs.

A main prerequisite for EU directional leadership is that if conflicts occur, the EU is able to mitigate and eventually solve them. A second prerequisite is that the conflicts and the way the conflicts are dealt with are 'typical', in the sense that the solutions can be transferred and /or generalised and applied to other countries. Then, we have a potential for directional leadership. Thirdly, the EU is, in fact, a directional leader if the other countries adopt the solutions. This section discusses possible conflicts among different groups and points at possible means to solve them that may give a potential for directional leadership.

### **4.1 Internal differences: Conflicts about the use of climate measures**

Internal conflicts between sectors within countries often relate to the choice of measures. Charges on emissions of CO<sub>2</sub> have been taken as a point of departure for analysing the costs of emission cuts. It is well known from textbook economics that a tax on emissions enables a country to achieve an emission target to the lowest possible cost. In practice, however, environmental taxes are seldom being used. Instead, environmental authorities prefer other measures, such as direct control. This may be because of practical difficulties in establishing a tax regime, or simply because a tax regime itself may generate conflicts if the tax-payers consider it to be unfair or unnecessary. However, the possibility of using alternatives to charges is limited, in particular in the case of CO<sub>2</sub> emissions, because the sources of a large part of the emissions are very small (individuals, households, small firms). When the sources of the emissions are small and dispersed, direct measures based on a close follow-up by the authorities easily becomes too costly to administer. Instead, general incentive mechanisms are usually preferred.

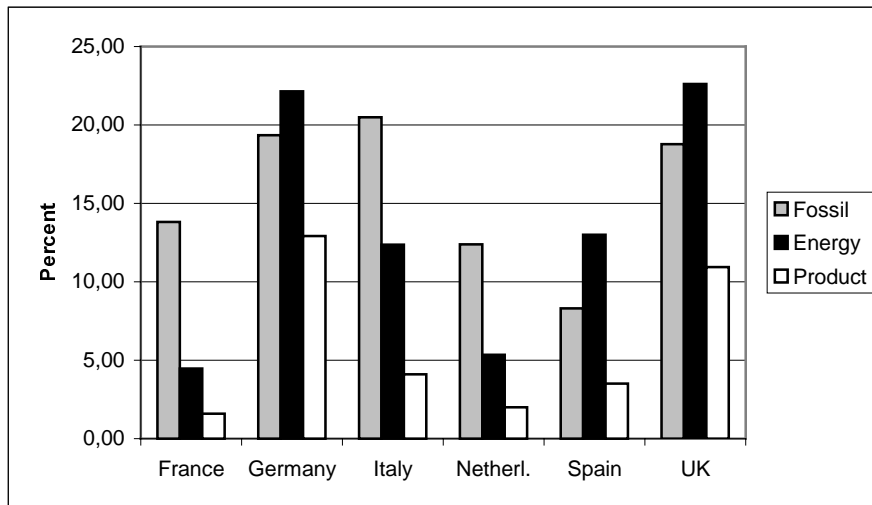
By the announcement of a carbon tax, the individuals immediately react to how they believe the cost of the tax will turn out to them. In terms of the calculations presented in the former section, this is the cost-push. However, the cost-push is not the same as the final cost of a tax, which emerges from the new equilibrium after the tax has been implemented. Therefore, some individuals will tend to exaggerate the cost of the tax. According the calculations, this applies especially to the industry sectors, which to some extent consist of large enterprises, where the costs of administrating direct measures, agreements etc. are more manageable than in sectors consisting of many small units. On the other hand, the possibilities of ineffective control are much greater, and the incentives to avoid charges are thereby higher. This may be due to asymmetric information and uncertainty about future costs of emissions control. The

enterprises may give good arguments for avoiding charges. Export industries fear the loss of competitiveness and warn against capital export. They could argue that charges may prevent them from investing in research and development and thereby represent an obstacle for innovation and cleaner processes. From an economic point of view, however, claims that charges are ‘too expensive’ are often – although not always – really claims that the national emission target is too ambitious.

There are many possible ways to confuse the connection between emission targets and the costs of achieving them, e.g. by means of an appropriate tax. A common argument is that the industry needs a stable framework under which the authorities want them to operate, *inter alia* because of the long-term nature of capital based production. They would rather know the quantity they are allowed to emit in the future than to adapt to an ever-changing charge. In principle, quotas may be just as effective as charges, but quotas would then have to be differentiated among activities. To assess the appropriate differentiation is extremely difficult and the result is, in fact, just as costly to the individuals as taxes. In practice, therefore, quotas apply only for some, usually large, enterprises.

A combined system with both quotas and charges easily become advantageous for those who obtain quotas at the expense of those subject to charges. One reason is that all the uncertainty about the national cost of achieving the target is loaded upon those who pay the charge. Second, the most significant options to reduce greenhouse gas emissions are often present in huge, but ineffective industries. A cost-effective strategy then implies that these industries reduce emissions much more than others. This may represent a considerable opportunity for lightening the burden of a climate policy to the big enterprises, since they will gain from any target milder than the cost-effective one, while the authorities may easily regard any quota stronger than the average as a “heavy burden”.

The conclusion is that the effect of a carbon charge on the production costs in the electricity sector and the industry sectors are keys to understand internal economic conflicts. These sectors face higher anticipated costs than the service sector in all the countries, and this may spur an immediate negative attitude to cost effective solutions. The main difference between these two sectors is that while the industry sectors face a high anticipated unit cost, the unit cost in the electricity sectors are very low. Hence, the industry sectors have incentives to search for new technologies as a result of the emission targets, while the electricity sectors have low incentives. However, the electricity sectors in Germany, the Netherlands and the UK are presently undergoing a substantial restructuring, which leads to lower emissions regardless of climate policy targets. As a consequence, one ought to study the cost-push in the industry sectors in the light of these changes. Figure 4.1 displays the cost-push for the aggregates in the industry sectors across countries.

**Figure 4.1: Cost-push of aggregates in the industry sector across countries.**

The restructuring of the electricity sectors in Germany, the Netherlands and the UK implies that the cost-push of the energy aggregate can be lowered considerably. This will also affect the product price considerably. Further reduction in the cost-push of fossils may lead to additional savings. By allowing for quotas by voluntary agreements in the industry and electricity sectors in these three countries, a substantial part of the national cuts may be achieved, and it may be relatively easy to make the other sectors accept other measures, such as charges. This applies in particular for the Netherlands, where emissions in all sectors can be reduced at low costs. Hence, the potential for conflicts related to an 'unfair' distribution of quotas is low.

The picture is quite different in the other three countries. Here, the potential for technological improvements in the electricity sector seems to be lower. This may increase the motivation for both the industry and the electricity sectors to obtain more moderate targets, but the trade-off towards the other sectors and the consequences for the national economy are more tangible. In Italy and France it may be difficult to increase the relative costs for the service sector in order to avoid conflicts in the electricity and the industry sector, not at least because of the large contribution from transport in the service sector. In Spain, the households already pay a very high price for emission cuts, if imposed by targets. Further reductions may be highly opposed. As a consequence, the choice of measures in these countries seems to be a more difficult task than in Germany, the Netherlands and the UK.

The question is then whether or not the EU can facilitate the selection of measures in any way. From the analysis above it is clear that the selection of measures is vital, but that different designs will apply for different countries in order to avoid internal conflicts. By this, we know at least what the EU should not do, which is to try to impose a system of common measures and instruments across the member states. Instructions about certain measures to be used may be acceptable for some countries, but are likely to generate conflicts in other countries. The EU might thereby run the risk of obstructing the achievement of radical targets for the region as a whole.

## 4.2 Differences and conflicts between sectors across countries

As pointed out earlier, the differences between sectors across countries measured by the cost-push indicators exhibit a rather similar pattern to the total cost-push shown in figure 4.1. Whether a difference between the cost-push of a given sector across countries is a major source of conflict depends, however, on the degree of international competition of the sector. It is difficult to distinguish clearly between internationally competing activities and non-competing activities, especially within the EU. Nevertheless, the different sectors are more or less exposed to competition from other countries. In general, manufactured goods are often used to illustrate changes in the competitiveness of an economy. Industry products also compete to a considerable extent with industries in countries outside the EU. We may therefore consider the industry sector to be more vulnerable to a loss of competitiveness than other sectors.

One way to make internal discrimination within a country legitimate is to argue that it is necessary to avoid a decline in the competitiveness of the national businesses. It was argued above that the conflicts related to an allocation of quotas that leaves the industry sectors in Germany, the Netherlands and the UK better off than with a carbon tax, are smaller than in the other three countries. In France, Italy and Spain the industry sector will probably expect the costs of emission cuts to be high, both because of the prior effectiveness of electricity production, and because the authorities have less opportunities in their choice of climate measures. The industry sectors in the northern countries may draw the advantage of the opportunity to make an influence on the choice of instrument. This clearly represents a source of conflict between countries. The industry sectors in the northern countries would achieve their targets with lower costs, thereby improving their competitiveness relative to that of the industry sector in the south.

This conclusion rests crucially on the different conditions in the electricity market across sectors. To put it bluntly, the three northern countries have more opportunities because the electricity system is emission intensive, and they can deliver their electricity at low prices, partly due to subsidies. The change in competitiveness thereby is both unfair and inefficient. It is difficult to point at specific measures taken within countries that could contribute to mitigate the differences in the cost-push across the sectors of different countries. However, a development of a common European market for electricity would contribute to mitigate these differences significantly. This is clearly an issue where a co-ordination of the EU is advantageous, and would probably also be ahead of many other regions. Provided that the EU succeeds in establishing a common electricity market, the possibility for taking directional leadership in climate policy would be improved, and in addition they would probably take directional leadership in energy policy.

## 4.3 National differences and conflicts

The six countries can be divided into two groups. The 'low-conflict' countries include Germany, the Netherlands and the UK, while France, Italy and Spain constitute the 'high-conflict' group. Although the conflicts may be explained by differences in the level of costs of emission cuts, they are not identical with costs. The conflicts are also a result of the possibilities available to the authorities to mitigate internal conflicts. The groups identified

here also correspond reasonably well with positions the countries have taken in climate issues within the EU, although non-economic factors, such as ‘greenness’, are often considered to be important to explain these positions. Some reservations should, however, be given for the Netherlands for which some studies confirm low costs (Kram and Hill, 1996) while others indicate high costs (Kram, 1998, Capros, 1998). Adding the aspect of conflicts emerging from economic differences also seems to strengthen the impression from the economic assessments just mentioned that there is a need for differentiation between the EU countries when it comes to the commitments related to the Kyoto protocol. Moreover, that the differentiation may be more related to economic factors than previously believed.

To find acceptable ways to differentiate targets among countries may reduce the potential for conflicts significantly. Contrary to the world society the EU possesses an institutional framework that has enabled it to differentiate targets internally. The EU also went further than any other of the large parties in Kyoto and proposed a 15 percent reduction of greenhouse gas emissions in 2010 relative to 1990. A prerequisite for this relatively radical proposal was that the EU managed to agree on an internal differentiation of targets. The proposal, as well as the differentiation agreed upon after Kyoto, was based on the so-called Triptych-approach (Phylipsen et al., 1999). This approach differentiates emission allowances according to three categories of emissions: Differences in the standard of living, the fuel mix and the competitiveness of internationally oriented activities. Hence, the Triptych approach is in many respects based on similar criteria as those discussed in this report. However the aspect of conflicts is not taken explicitly into account. The same holds for the national levels of energy prices, which have an important impact on the results of this study.

Whether the respect to possible conflicts would change the distribution of targets for the EU countries is hard to say, because it is not entirely clear what the assumptions about the baseline, or emissions without targets in 2010, was. For example, the standard of living category was used as an argument to give additional emission allowances to the so-called Cohesion-countries, which include Spain, but it is difficult to say how much this means in terms of the emission targets. The targets for the six countries are (pct. change from 1990 to the period 2008-2012)

France	0.0 percent
Germany	-21.0 percent
Italy	- 6.5 percent
The Netherlands	- 6.0 percent
Spain	15.0 percent
United Kingdom	-12.5 percent

The differentiation agreed upon after Kyoto may mitigate some of the internal conflicts within the EU, but according to this study there are a number of potential conflicts left. Although the three “low conflict” countries all will have to reduce their emissions, it is possible that the huge differences may spur conflicts. On the background of the seemingly small potential for conflicts, it seems that the Netherlands has achieved a good agreement. This conclusion is partly based on the low costs of emission cuts calculated for the Netherlands. A reason why the Netherlands has got a relatively moderate target may be the low price-level of gas in 1990, which was not explicitly taken into account in the Triptych approach. It is also difficult to explain why Germany should reduce their emissions nearly twice as much as the UK, but this

may be due to the ineffective industrial sector in the former DDR, which has not been analysed into depth here.

For the “high conflict” countries, it appears that Italy’s target is very hard to achieve without conflicts. Again, the prices of energy may explain why it is difficult for Italy to reduce emissions without conflicts, while at the same time, the Triptych approach, which emphasises the energy mix, prescribes cuts at approximately the same level as for the Netherlands. On the other hand, the most severe conflicts in Spain may be overcome by the allowance of a 15 percent increase in its emissions. The fact that energy prices, which is assumed to be high in Spain in this analysis, is not explicitly considered in the Triptych approach, indicates that the differentiation according to the different levels of the standard of living may have been overemphasised when assessing targets for individual EU countries.

Apart from the fact that differentiation is important to avoid conflicts, one should also be aware that if it is considered unfair or inappropriate by one of more parties, new and more serious conflicts might occur as a result. The differentiation of targets within the EU under the Kyoto protocol will probably contribute to a mitigation of conflicts, although some factors could probably be emphasised more in order to avoid them. In particular, the different price levels for energy in various countries do not seem to have been taken sufficiently into account. More competition in the electricity market may reduce the importance of this aspect, but, on the other hand, make the ‘winners’ and ‘losers’ of the present differentiation more visible.

## 5 Concluding remarks

The EU has expressed an interest in acting as a leader in climate negotiations. As pointed out in Gupta and van der Grijp (1998), leadership may be interpreted in different ways, and how EU leadership is to be understood in this context varies a lot within the EU. In this report, we have emphasised directional leadership, that is, leadership by example (Underdal, 1994), and assumed that solution of conflicts within the EU could be used as a model for how conflicts might be solved. The aim of this paper has been to detect potential conflicts by comparing the economic consequences of emission cuts in six countries. This is a first step to approach the leadership issue, but is not sufficient. The realism of EU solutions applied on the world in general has not been analysed.

Potential conflicts are viewed as a result of differences in the expected costs of emission reductions. According to the analysis, the six countries focused here divide into two groups. Germany, the Netherlands and the UK seem to constitute the 'low-conflict' group and France, Italy and Spain constitute the 'high-conflict' group. For Germany and the Netherlands, the costs thereby support their 'green' image. However, this is not to say that the German and the Dutch governments are not 'greener' than the other countries. According to this study, cutting CO<sub>2</sub> emissions are less costly in these countries than in the other three, but it does not tell how much. For example, the Netherlands' support of a European carbon tax is easily explained by a concern for climate change, and can hardly be seen as a consequence of their economic interests.

The EU has met this challenge by differentiating the targets substantially between the member states to avoid conflicts. The lesson for the world society is perhaps that the differentiation agreed upon in Kyoto is far from being sufficient, and that there is a room for larger cuts for the Annex B countries taken together if the targets are differentiated more among countries. One may, however, seriously ask whether the EU wants to take directional leadership on this issue. EU was against differentiation in Kyoto. The other side of this coin is that by differentiating more within the EU, they achieve larger emission cuts, thereby managing to strengthen their leadership role on the general target issue.

The analysis also shows that it seems to be important for some of the countries, UK in particular, to discriminate some sectors of the economy where the potential for emission cuts is large, in order to avoid conflicts. Also the UK's insisting on the subsidiarity principle (Dahl, 1998) is thereby supported by the economic consequences. A nationally sovereign policy can be carried out by a combination of different measures and instruments, adapted to the circumstances in each country. Sectors with large potentials and strong political influence will prefer physical targets, while incentives will be preferred for smaller units. Moreover, the distribution of commitments within such a combined system of measures will have to differ substantially between countries in order to avoid large conflicts. Therefore, an attempt to impose common measures across countries may lead to less ambitious targets for the EU as a whole.

The analysis also demonstrates the vital role played by the electricity sector. A large part of the differences in costs across the countries focused in this study can be traced back to the opportunities and the conditions in the electricity sector. As a consequence, a co-ordination of the electricity market in Europe will make a major contribution to reducing the conflicts

between countries. This is perhaps the issue where the potential for EU leadership is most significant, but also very challenging. Previous attempts to approach a common electricity market in the EU have had little success. This also explains the difficulties in establishing a common climate policy (Wettestad, 1998). Hence, the key to success for EU leadership on climate change may be a co-ordination of the electricity market within the Union.



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